Fibers in Micro Surfacing

FINAL REPORT

August 20, 2021

By Mansour Solaimanian, Scott Milander
and Ryan Christensen

The Pennsylvania State University

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Tom Welker (twelker@pa.gov), Municipal Services Specialist, served as the project technical advisor.

16. Abstract

Micro surfacing is considered one of the well-established techniques for pavement preservation. It has been used for both low-volume and high-volume roads for a few decades. At the same time, glass fibers have been promoted for use as a reinforcing agent in micro surfacing to improve flexibility and fatigue resistance. This project was undertaken to determine if the durability of this product could be extended through the incorporation of fibers into the micro surfacing mix. This research was conducted with the objective of investigating the laboratory and field performance of micro surfacing mix when glass fiber is incorporated into the mix. The results of the study may be used by PennDOT to develop pertinent specifications for inclusion in PennDOT Publication 447 (Pub 447). There were five parts to this study: (1) a brief literature review; (2) visit to a field project before, during, and after placement of the micro surfacing; (3) laboratory testing of the micro surfacing using the wet track abrasion in accordance with ISSA TB100; (4) data analysis and reporting; and (5) recommendations for specifications. Based on the results of this study and literature review, recommendations for development of specifications were developed. Those recommendations were submitted in a separate document, with the final goal of possible inclusion of the specifications on fiber-reinforced micro surfacing in PennDOT Publication 447.

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Disclaimer

Table of Contents

List of Figures

List of Tables

CHAPTER 1

Introduction

Micro surfacing is considered to be one of the well-established techniques for pavement preservation. It has been used for both low-volume and high-volume roads for a few decades. At the same time, glass fibers have been promoted for use as a reinforcing agent in micro surfacing to improve flexibility and fatigue resistance. This project was undertaken to determine if the durability of this product could be extended through the incorporation of fibers into the micro surfacing mix.

OBJECTIVE OF THIS RESEARCH

This research was conducted with the objective of investigating the laboratory and field performance of micro surfacing mix when glass fiber is incorporated into the mix. The results of the study may be used by PennDOT to develop pertinent specifications for inclusion in PennDOT Publication 447 (Pub 447).

SCOPE OF WORK

There were five parts to this study: (1) a brief literature review; (2) visit to a field project before, during, and after placement of the micro surfacing; (3) laboratory testing of the micro surfacing using the wet track abrasion in accordance with ISSA TB100; (4) data analysis and reporting; and (5) recommendations for specifications.

CHAPTER 2

Literature Review

A brief literature review was conducted to collect documented information on the use of fibers in micro surfacing. This review was specifically focused on the results from the field studies done by the pavement preservation partnership between the Minnesota Road Research Facility (MnRoad) and National Center for Asphalt Technology (NCAT). Vargas-Nordbeck (2019) reports on the field performance of micro surfacing treatments as a result of work done under this partnership. The report addresses the performance of various treatment strategies applied on two different highways in Alabama. Among several different strategies applied to one of the highways (US-280 in Alabama), two were single-layer micro surface treatments placed with and without fibers. In the conclusion, the author states that "*the best overall performers included some of the more robust treatments such as double layer applications and a cape seal, as well as enhanced single layer applications that incorporate fibers and high polymer content*."

Some other past research highlights the benefits of fiber in micro surfacing based on the laboratory performance (Pavement Preservation Recycling Summit, 2015). In this summit, presentation was made on the use of the flexural beam test to indicate higher performance of fiber-reinforced micro surfacing compared with conventional micro surfacing. The results from this test indicated the fiber-reinforced micro surfacing significantly tolerated a higher failure load and higher fracture energy compared with the conventional micro surfacing (Figure 1). In the same presentation, discussion was made of a field project in China using micro surfacing with and without fiber. The results from field observations indicated lower intensity of both transverse and longitudinal reflective cracking after 8 months and after 25 months for the fiber-reinforced micro section compared with the section with conventional micro.

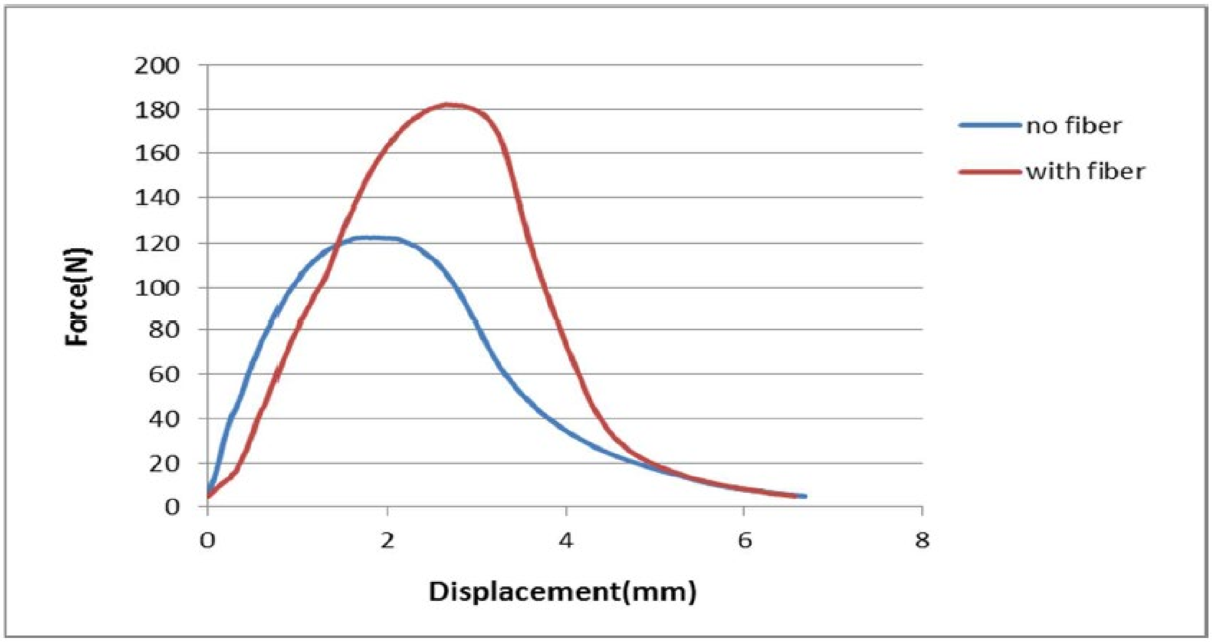


Figure 1. Better performance of micro surfacing with fiber compared with conventional micro under flexural beam test (higher peak load and higher absorbed failure energy as obtained from the area under the curve (Charmot et al., 2015).

CHAPTER 3

Methodology

MONITORING THE FIELD PROJECT

Review of Existing Pavement before Placement (July 6, 2020)

The road for the pilot micro surfacing project was the Kenneth Road in West Manchester Township of York County, PA. Review of the existing pavement took place on July 6, 2020. Visit of the site took place by the principal investigator and the project technical liaison, who coordinated all research-related activities with the township and the contractor. The visual survey was conducted from the roadside with no traffic control or direct access to the road. The existing pavement appeared to be structurally sound. No visible signs of raveling or bleeding of the roadway were found. Rut depth was not measured but did not appear to be noticeable. There were areas of transverse and longitudinal cracks, all of which were recently sealed. Pictures were taken from the surface and mapping of the crack pattern was conducted as provided in Appendix A. Examples of the surface condition are presented in Figures 2 through 6. The road has annual daily traffic (ADT) of roughly 3,000.

Figure 2. General view of the existing pavement (picture taken at intersection with Trolley Road).

Figure 3. Southbound with sealed transverse cracks.

Figure 4. Southbound with sealed longitudinal cracks.

Figure 5. General view of the existing pavement (picture taken at intersection with Loucks Road).

Figure 6. Close-up view of surface texture of existing pavement.

Documentation of Material Placement (July 7, 2020)

Three test sections of micro surfacing were placed on Kenneth Road between Loucks Road and Trolley Road in Manchester County. The test sections received a scratch layer application of Type A micro surfacing followed by main layer application of Type A micro surfacing. The scratch layer was placed at an application rate of approximately 15 lb/yd^2. The top layer was placed at 32 to 35 lb/yd^2. The northbound and the center lane were placed with a micro surfacing mix that included glass fibers at a rate of roughly 0.2% by the weight of the mix. The southbound was placed as the control section, with a micro surfacing mix that did not contain fibers. Placement of material in all lanes took place moving in the southbound direction. First, placement of the northbound took place, followed by the center lane and the southbound, respectively. The material was placed on a cloudy day with ambient temperature ranging between 75–80 °F (24–27 °C) during placement. The existing pavement temperature varied in the range of 90–96 °F (32–36 °C) during placement. When placing the center lane mix, the road marking paint was first tacked to ensure adequate bond between the micro surfacing and the underlying pavement. The placed material was rolled using a pneumatic tire roller for compaction. The compaction rolling was not conducted on the scratch layer. Figures 7 through 15 present different stages of material placement.

During the placement, eight 1-quart cans of the emulsion and four 5-gallon buckets of aggregate were received. These materials were transported to the NECEPT laboratory to prepare specimens for laboratory testing. The fiber was provided to the research team by the fiber vendor.

Figure 7. The scratch layer of fiber-reinforced micro surfacing placed on the northbound lane.

Figure 8. The top layer of fiber-reinforced micro surfacing placed on the northbound lane.

Figure 9. A close-up view of the micro surfacing texture on the northbound lane.

Figure 10. Cured micro on the northbound (far side) and freshly placed micro on the center lane.

Figure 11. Completed micro (northbound), freshly placed scratch micro (center lane), and existing pavement to be paved (southbound).

Figure 12. Placement of second layer of micro on the center lane.

Figure 13. Freshly placed micro on the center lane.

Figure 14. Compacting the center lane micro (second layer).

Figure 15. Completed micro on the southbound lane.

Site Visit and Initial Evaluation after Placement (July 23, 2021)

This visit took place roughly one year after placement and was conducted by the principal investigator and the project technical liaison. The road appeared to be in great shape on both the control and fiber sections as evidenced in Figures 16 through 22. There were no signs of cracking, rutting, bleeding, raveling, or material loss. This was expected, as the placed mix was only about a year old. At the intersection with Loucks Road, a moderate level of rutting and flashing of the control section was observed due to standing vehicles at the traffic light (Figure 23). At the intersection with Trolley Road on the northbound, loss of material was observed on the right-hand side of the experimental section but limited to a very small area (Figures 24 and 25).

Figure 16. A close-up view of the surface texture on the southbound one year after placement.

Figure 17. A general view of the micro after one year in service, looking southbound.

Figure 18. Another view of the micro after one year of service.

Figure 19. Excellent performance and texture after one year of service (looking southbound).

Figure 20. General view of the micro after one year of service (looking northbound).

Figure 21. Another view of the micro after one year of service looking northbound.

Figure 22. Excellent texture and appearance of the mat on all three lanes.

Figure 23. Minor rutting and bleeding on the southbound lane at the intersection.

Figure 24. Localized loss of material on the northbound lane at the intersection with Trolley Road, possibly because of inadequate application or compaction.

Figure 25. A close-up view of the localized material loss on the northbound lane at intersection with Trolley Road.

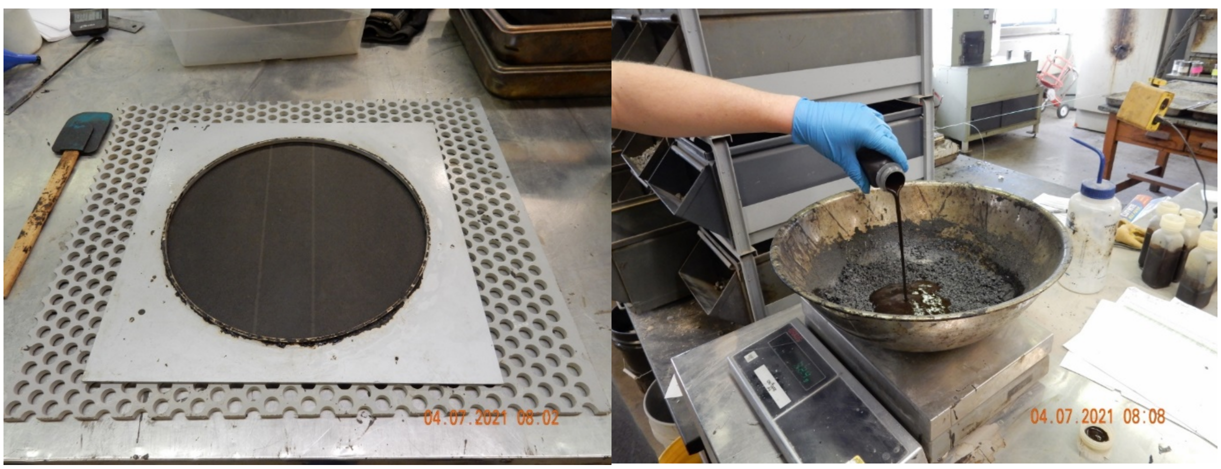
LABORATORY TESTING

The durability of the micro surfacing mix was evaluated under wet abrasion conditions according to the most recent version of International Slurry Surfacing Association (ISSA) TB 100, published in 2018. This was the only laboratory test conducted to check the material durability as part of this research. The wet track abrasion loss is typically conducted at the mix design stage along with other tests such as wet cohesion, wet stripping, and sand adhesion using the loaded wheel tester. The results from the wet track abrasion test were compared with the target values recommended by PennDOT requirements as outlined in Section 483 of Construction Specification 408. These requirements match the requirements covered in ISSA Performance Guidelines for Micro Surfacing A143 (revised in May 2020). Materials for the laboratory testing were obtained during the field visit of July 7, 2020, when the micro was placed.

Specimen Preparation

ISSA A143 specifies two curing conditions for the wet track abrasion test: 1-hour soak and 6-day soak. For this research, both the 1-hour and 6-day conditioning protocols were applied. A total of 18 specimens were prepared: 9 without fiber (control specimens named Group I) and 9 specimens with fiber (experimental specimens named Group II). Five specimens of each group were subjected to 1-hour soak before the wet track abrasion test, while the remaining 4 specimens from each group were subjected to 6-day soak before the abrasion test. The 6-day soak procedure is included for evaluation of the mix long-term moisture susceptibility. For this project, an application rate of 32 lb/yd^2 was followed to fall in the range of the application rate used in the field. The proportion of the ingredients was established based on the submitted mix design. The specimens fit a circular mold with an 11-inch diameter. The steps followed to create and test a specimen, as shown in Figures 26 through 28, are as follows:

- Place the felt paper on top of a sheet of perforated plastic.
- Place the circular mold on top of the paper, leaving about ½ inch on all sides.
- Preheat the emulsion at 60 °C for 30 minutes.
- In a mixing bowl, place 877.2 grams of aggregate.
- Add 8.8 grams of cement powder to the aggregate.
- If including fibers, add in 3.5 grams of the fiber.
- Mix in 73.7 grams of water and stir the mixture to ensure the entire mixture is uniformly damped.
- Add in 105.3 grams of heated emulsion.
- Mix the emulsion in for 30 seconds.
- Once mixed, pour the mixture into the mold favoring one side.
- Using a dowel rod or window squeegee, gently spread the mixture evenly across the mold, making sure no divots are pressed into the felt paper.
- Place the mold into a 60 °C oven until it dries to a constant mass, no shorter than 15 hours, no longer than 30 hours.



(a) (b)

Figure 26. (a) The mold setup with the enclosed felt, (b) adding the heated emulsion to the wetted aggregate.

(a) (b)

Figure 27. (a) The micro surfacing material poured into the mold, (b) spreading the micro surfacing material using the wooden dowel rod to evenly spread across the mold to uniform thickness.

Figure 28. Micro surface specimen clamped in the abrasion pan with the pan filled with water before testing.

Testing

In brief and as explained in the test protocol, the prepared micro surfacing mixture is immediately cast into the specified mold and struck off flush. After removal of the mold, the specimen is cured by drying to a constant weight at 140 °F (60 °C). The cured specimen is immersed in a 77 °F (25 °C) water bath for a period of 1 hour or 6 days, then mechanically abraded under water with a weighted rubber hose for a specified time. The specimen is then washed free of abraded material and dried to a constant weight. The loss in weight is expressed in grams and then loss per unit area is calculated. Figure 29 shows one of the specimens before and after testing.

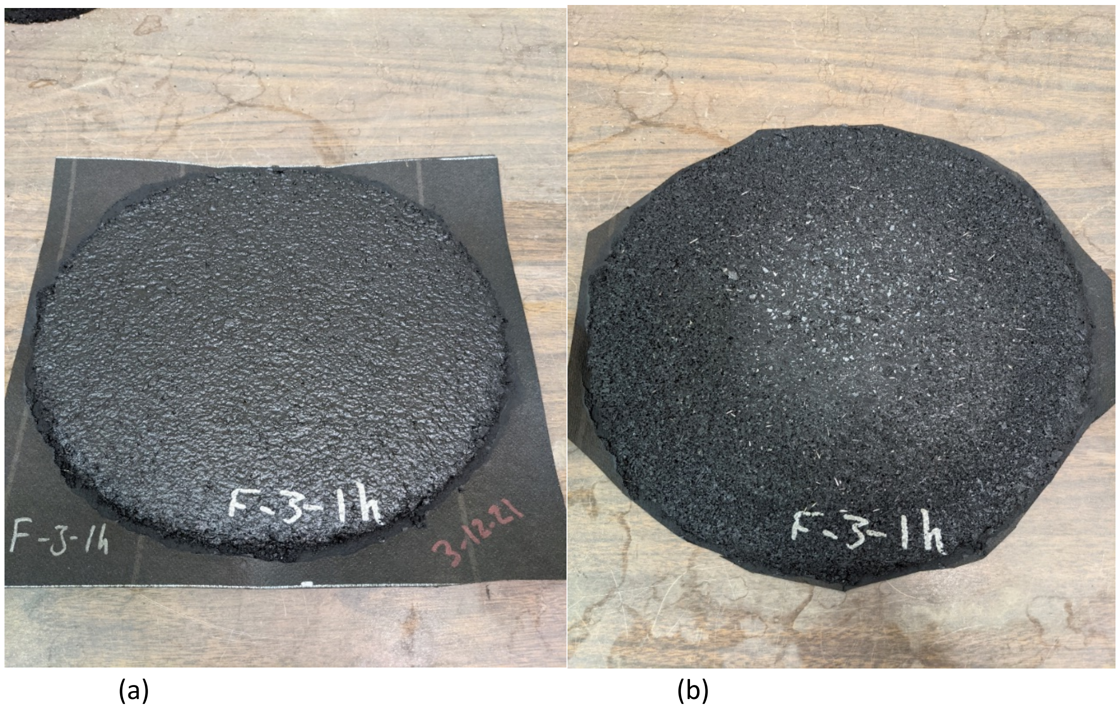


Figure 29. (a) The specimen with fiber before conditioning and testing, (b) the specimen after 1-hour soak and after completion of testing.

For this project, there were two different types of testing: 1-hour and 6-day soaking periods. Each time, two specimens were made and tested as a pair under the same conditions: one specimen with fiber and one specimen without fiber. The testing followed ISSA TB-100 standard; the procedure is as follows:

- Preheat the water bath to a constant 25 °C, maintaining the temperature fluctuation within ±0.4 °F (0.2 °C).
- Fully submerge the specimen in the constant-temperature water for the duration of 1 hour or 6 days.
- Prepare the planetary mechanical mixer with the attached abrasion head and the hose.
- After the soaking duration has been completed, place the specimen in the abrasion pan underneath the mechanical mixer.
- Clamp the specimen down to the abrasion pan and pour in water to submerge the specimen to a depth of 6.35 mm. The water must be at a temperature of 77 °F (25°C).
- Raise the abrasion pan to the abrasion head and lock it in and run the stand mixer for 405 seconds.
- Once the abrasion has finished, remove the specimen from the abrasion pan and run the specimen under water, ensuring all loose particles fall off.
- Place the specimen in a 140 °F (60 °C) oven to dry to a constant mass. The drying time shall not be shorter than 15 hours or longer than 30 hours.

- The mass loss is determined using the original weight and the weight of the dried specimen after the test.

Analysis

The data for all 18 specimens are presented in Table 1. Specimens of both 1-hour soak and 6-day soak are included in the table. The mass loss is reported in the last three columns: the mass difference, the percent mass loss, and the converted mass loss per unit area. This last item is calculated following the procedure defined in ISSA A143. According to ISSA A143, the maximum loss from wet-track abrasion loss, when done for a 1-hour soak, shall not exceed 75 g/ft^2. It can be seen that in none of the cases, after removal of outliers, was this limit exceeded.

The variability noticed in the data for some of the specimens triggered identification of any outliers. In statistics, a data point (observation) that is significantly different from other data points (observations) is referred to as an outlier. The term “significant” is important, as a sound statistical approach must be followed to identify an outlier. The number of data points for this experiment is limited, as only five specimens were used for each type of mix under the 1-day soak and four specimens for each type of mix under the 6-day soak. Two methods were used to determine any outliers in the data set: the box and whisker plot and the Dixon Q test (or simply Q test).

Table 1. Detailed results from wet track abrasion test (ISSA TB 100).

Specimen ID	Initial Weight	Water Bath Duration	Date Tested	Final Weight	Mass Difference	Mass Loss	Loss per Unit Area
ID	g			g	g	%	g/ft^2
Control_1_1h	945.5	1 hour	3/2/2021	937.0	8.5	0.90	27.6
Control_2_1h	933.3	1 hour	3/9/2021	933.0	0.3	0.03	1.0
Control_3_1h	935.8	1 hour	3/16/2021	933.0	2.8	0.30	9.1
Control_4_1h	933.9	1 hour	3/26/2021	928.6	5.3	0.57	17.2
Control_5_1h	931.5	1 hour	4/6/2021	924.1	7.4	0.79	24.1
Fiber_1_1h	953.7	1 hour	3/3/2021	951.0	2.7	0.28	8.8
Fiber_2_1h	930.5	1 hour	3/9/2021	923.8	6.7	0.72	21.8
Fiber_3_1h	949.5	1 hour	3/17/2021	943.1	6.4	0.67	20.8
Fiber_4_1h	935.8	1 hour	3/26/2021	928.0	7.8	0.83	25.4
Fiber_5_1h	942.0	1 hour	4/6/2021	934.0	8.0	0.85	26.0
Control_1_6d	938.1	6 days	3/17/2021	929.9	8.2	0.87	26.7
Control_2_6d	934.4	6 days	3/30/2021	926.8	7.6	0.81	24.7
Control_3_6d	953.1	6 days	4/7/2021	944.1	9.0	0.94	29.3
Control_4_6d	930.2	6 days	4/13/2021	913.2	17.0	1.83	55.3
Fiber_1_6d	946.2	6 days	3/17/2021	942.6	3.6	0.38	11.7
Fiber_2_6d	945.7	6 days	3/30/2021	935.8	9.9	1.05	32.2
Fiber_3_6d	918.3	6 days	4/7/2021	913.9	4.4	0.48	14.3
Fiber_4_6d	935.6	6 days	4/13/2021	899.2	36.4	3.89	118.4

The first approach for identification of the outliers was through the use of the box and whisker plot, which presents the distribution of data using quartiles. The summary of data is presented with five numbers: minimum value, first (lower) quartile, median, third (upper) quartile, and maximum value. The first quartile (Q1) presents the value exceeding 25% of the values. The third quartile (Q3) presents the value exceeding 75% of the values. The interquartile range (IQR) is the difference between Q3 and Q1 and shows the middle 50% of data. The upper and lower whiskers show the data that land outside the middle 50% of the data. To determine the outliers based on the box and whisker plot, two values are calculated: LL (lower limit)=Q1-1.5×IQR and UL (upper limit)=3+1.5×IQR. Any value below LL or higher than UL is considered an outlier. Through this approach it was found that none of the values could be removed as an outlier.

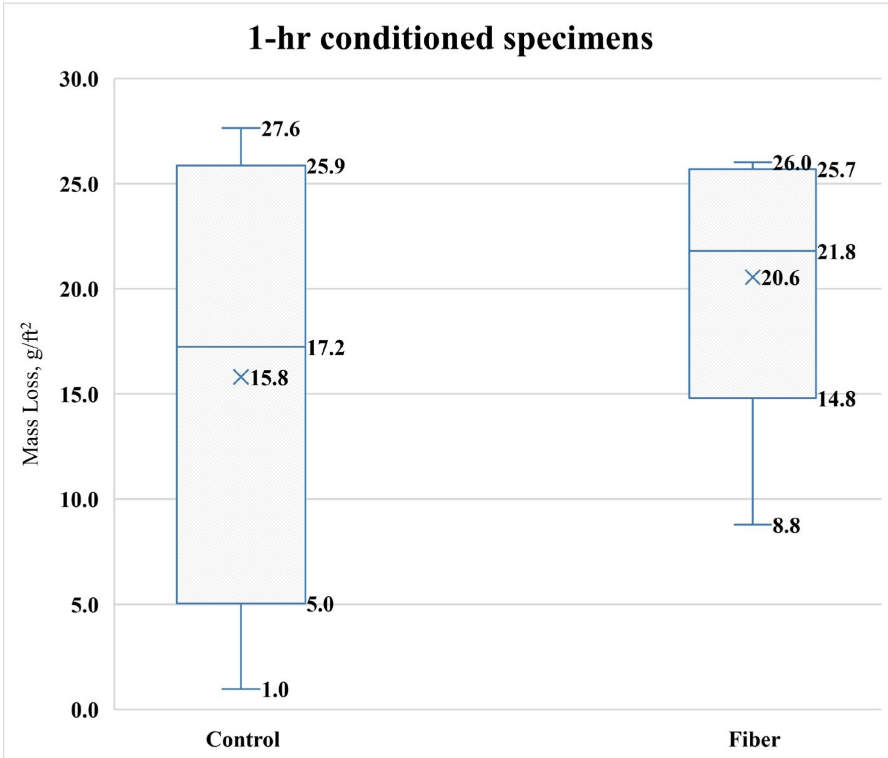


Figure 30. Box and whisker plot for identifying the 1-hr outliers.

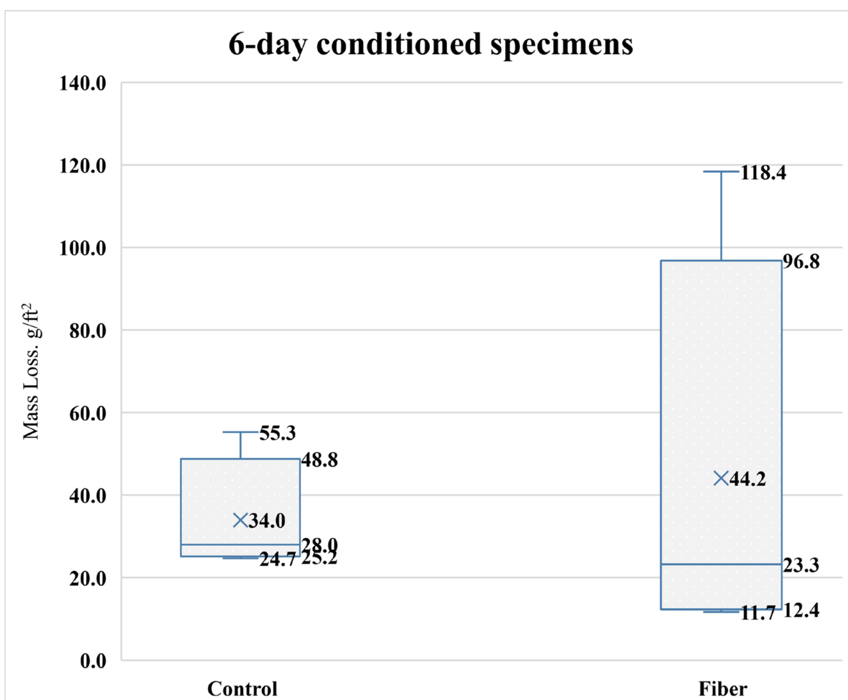


Figure 31. Box and whisker plot for identifying the 6-day outliers.

The Dixon Q test, the second method used in this work, follows a simple approach to identify and reject outliers. To use this test, it is assumed that the data set follows a normal (Gaussian) distribution. The statistic experimental Q value is calculated as the ratio of the difference of the suspect value from its nearest one divided by the range of the values. The result of this calculation is referred to as the experiment Q, and it must exceed the critical Q, which is established at a specified confidence level. Table 2 shows the critical value of Q at different confidence intervals and sample sizes. In this research, two confidence levels of 95% and 90% were used and a two-tailed Q test was applied. For the 1-hour cured condition, five specimens were tested and therefore, $Q_{critical}$ was 0.710 for the 95% confidence interval and 0.642 for the 90% confidence interval. Similarly, $Q_{critical}$ was established for the 6-day soak tests.

Table 2. Critical values of Q for different confidence intervals and sample sizes.

	Q_{crit} for a Given Confidence Interval (CL)		
N (Number of Specimens)	**CL=90%**	**CL=95%**	**CL=99%**
3	0.941	0.970	0.994
4	0.765	0.829	0.926
5	0.642	0.710	0.821
6	0.560	0.625	0.740
7	0.507	0.568	0.680
8	0.468	0.526	0.634
9	0.437	0.493	0.598
10	0.412	0.466	0.568

The results are presented in Table 3. At 95% CL, the only outlier belongs to one test of the 6-day soaks of the control group (55.3 grams). At 90% CL, there are three outliers as shown in the table. It should be noted that the 118.4 grams loss of the fiber mix for the 6-day soak almost meets the 95% outlier level ($Q_{experiment}$ of 0.81 versus $Q_{critical}$ of 0.83). The value of 118.4 grams seems drastically different from the other three values in the set and can be safely considered an outlier. After removal of the outliers, a statistical student t-test was conducted to determine if there was a significant difference between the mass loss of the control specimens and that of experimental specimens. The results are shown in Tables 3 and 4 and indicate no significant difference between the two groups.

Table 3. Determination of outliers for mass loss per unit area based on the Q test.

	Soak Period			
	1-hr		6-days	
Confidence Interval	Control	Fiber	Control	Fiber
95%	None	None	55.3	None
90%	None	8.8	55.3	118.4

Table 4. Two-sample t-test for 1-hr specimens assuming unequal variances.

1-hr Conditioned Specimens		
	Control	*Fiber*
Mean (loss in g/ft²)	15.8	20.6
Variance	118.8	48.3
Observations	5	5
Hypothesized Mean Difference	0	
df	7	
t Stat	-0.821	
P(T<=t) one-tail	0.219	
t Critical one-tail	1.895	
P(T<=t) two-tail	0.439	
t Critical two-tail	2.365	
No significant difference based on t Test		

Table 5. Two-sample t-test for 6-day specimens assuming unequal variances.

6-day Conditioned Specimens		
	Control	*Fiber*
Mean (loss in g/ft²)	26.9	19.4
Variance	5.2	124.4
Observations	3	3
Hypothesized Mean Difference	0	
df	2	
t Stat	1.138	
P(T<=t) one-tail	0.187	
t Critical one-tail	2.920	
P(T<=t) two-tail	0.373	
t Critical two-tail	4.303	
No significant difference based on t Test		

CHAPTER 4

Recommendations and Conclusions

RECOMMENDATIONS FOR SPECIFICATIONS

Based on the results of this study and literature review, recommendations for development of specifications were developed. Those recommendations were submitted in a separate document, with the final goal of possible inclusion of the specifications on fiber-reinforced micro surfacing in PennDOT Publication 447. Recommendations made under this research regarding changes in PennDOT specifications are subject to review and consideration by PennDOT for inclusion in specifications and final implementation. It is understood that specification changes are required to follow a normal process of review and discussion, including the clearance transmittal process, sometimes a lengthy process. Obviously, the final decision and responsibility for any revisions to specifications remains with PennDOT.

SUMMARY AND CONCLUSIONS

Under PennDOT sponsorship, a 15-month research project was undertaken by Penn State to investigate the performance of fiber-reinforced micro surfacing on low-volume roads. A test section was paved in July 2020 with micro surfacing in York County, PA with and without inclusion of glass fibers in the micro mix. The pavement condition was assessed the day before placement, the placement process was documented, and a follow-up visit took place one year after placement. In addition, a brief literature review was conducted, and laboratory wet track abrasion tests were conducted on the specimens prepared with the same materials used for the field project. Finally, recommendations were made for development of PennDOT specifications.

The pavement before placement of micro appeared structurally sound. The only noticeable distresses were a low to moderate level of longitudinal and transverse cracks that were sealed before micro surfacing. The placement of micro surfacing mix was conducted without major issues. Performance of all lanes one year after placement was found to be excellent. This was expected, as the placed material was only one year old. The benefit of fibers in micro may become evident in 5 to 6 years after placement. Hence, it is recommended that all lanes of the test section be monitored once annually for the next 4 to 5 years.

Laboratory testing using the wet track abrasion test did not show any difference in terms of performance. It must be noted that this conclusion is based only on the durability test conducted according to ISSA TB 100. No other laboratory tests were performed to compare performance.

References

Charmot, S., Yifan Y., Shi, M., Hu, H., and Zheng, Z. (2015). Measurement of the Effectiveness of Fiber Reinforced Micro Surfacing Mixtures. Pavement Preservation & Recycling Summit, PARIS, February.

Vargas-Nordcbeck, A. (2019). 6-Year Study on Micro Surfacing. *Proceedings, American Society of Civil Engineers, Airfield and Highway Pavement Conference*, pp. 189-197.

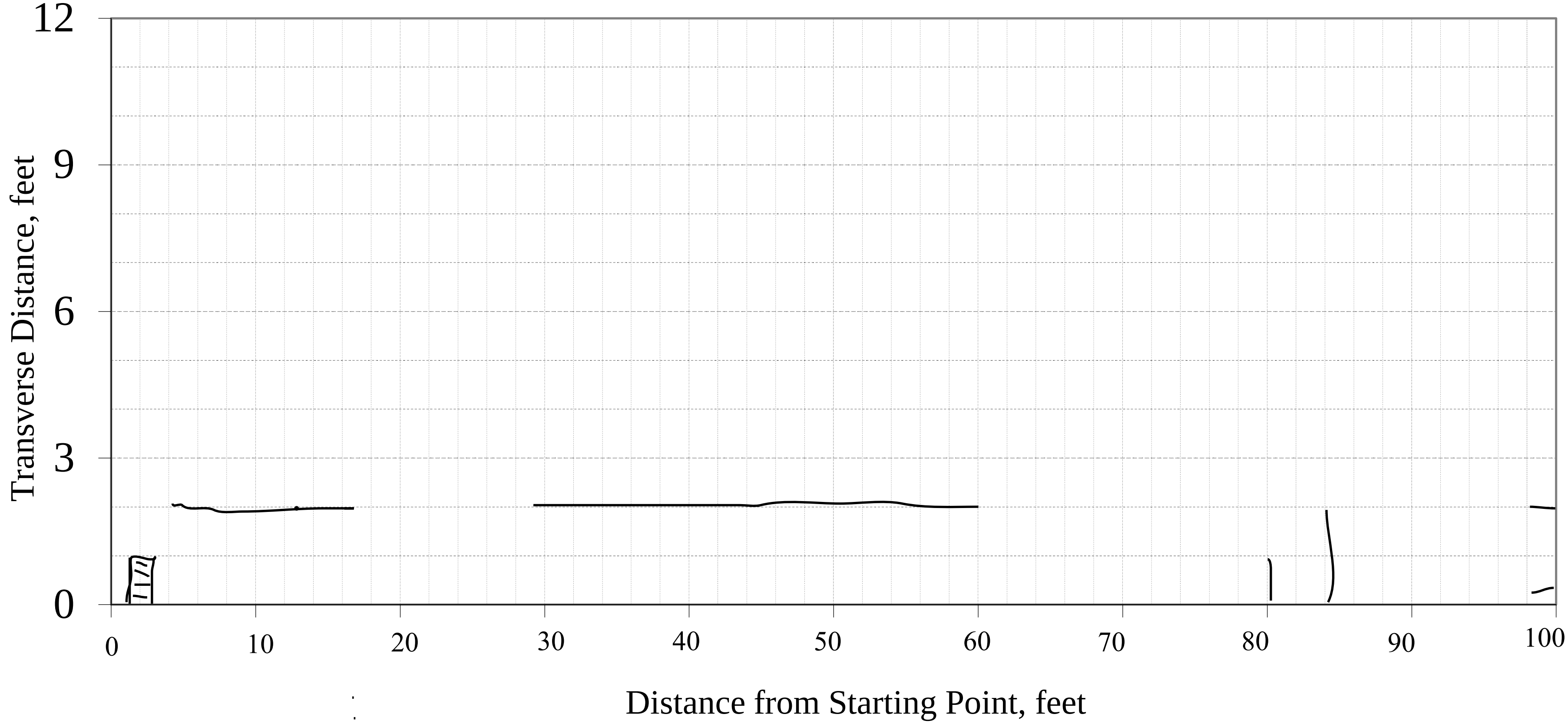
Appendix A: Distress Mapping of Existing Pavement before Placement of Micro
Project: PennDOT ECMS WO#3 - Micro Surfacing with Fiber

Date/Time: Jul 6, 2020

Surveyed by: M. Solaimanian

County: York

Route: Kenneth Road
Bound: South
Segment:
Offset:
Lane: Travel



REMARKS:

- Zero Mark is at the Torlley Rd., right before the catch basin storm drain.
- All shown cracks on this page and subsequent pages have been sealed and are not visible.
- Survey was conducted from the roadside.
- Location and length of all mapped cracks are approximate.
- The road is in good shape. Raveling is minor,. There was no visible rutting.

Distress Survey Form

Appendix A: Distress Mapping of Existing Pavement before Placement of Micro
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Surveyed by: M. Solaimanian

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Route: Kenneth Road
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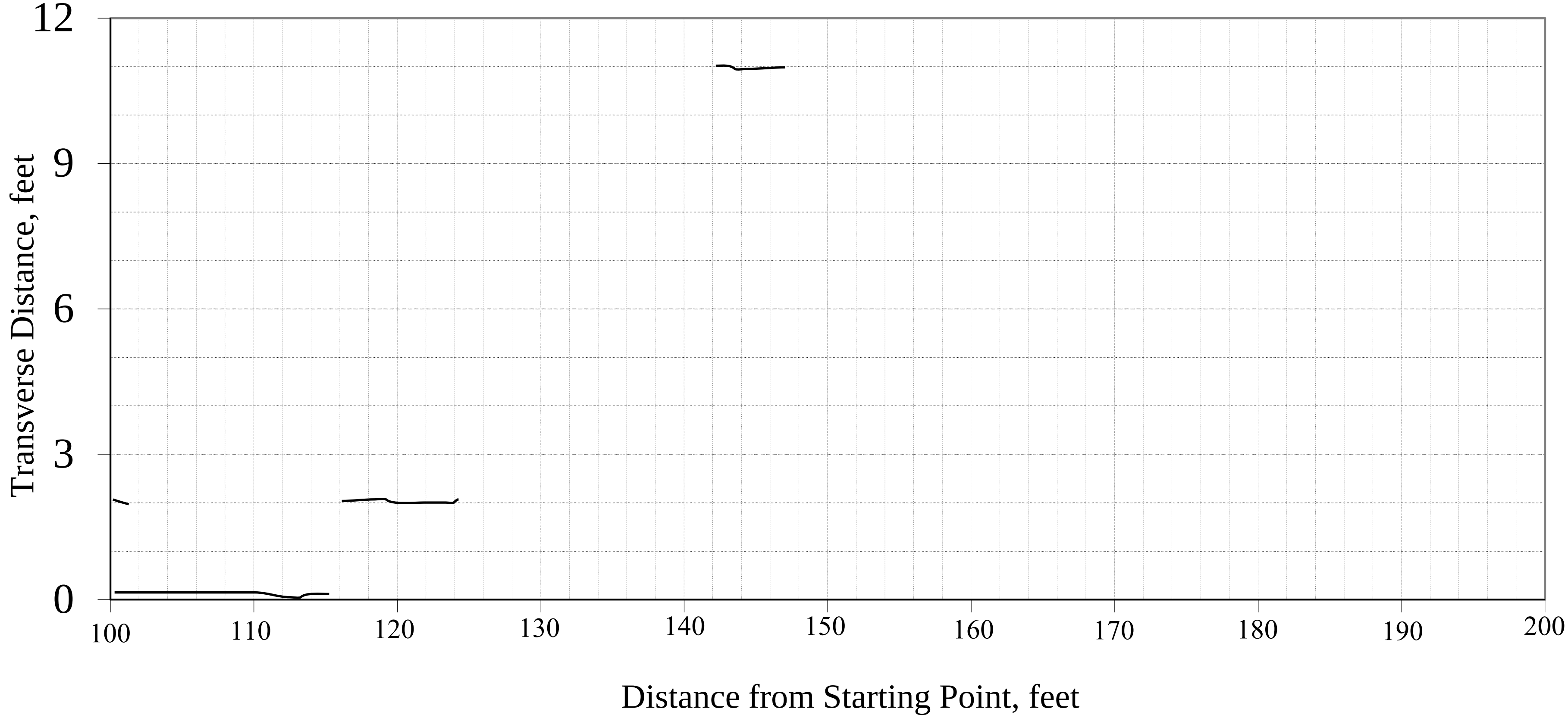
Lane: Travel



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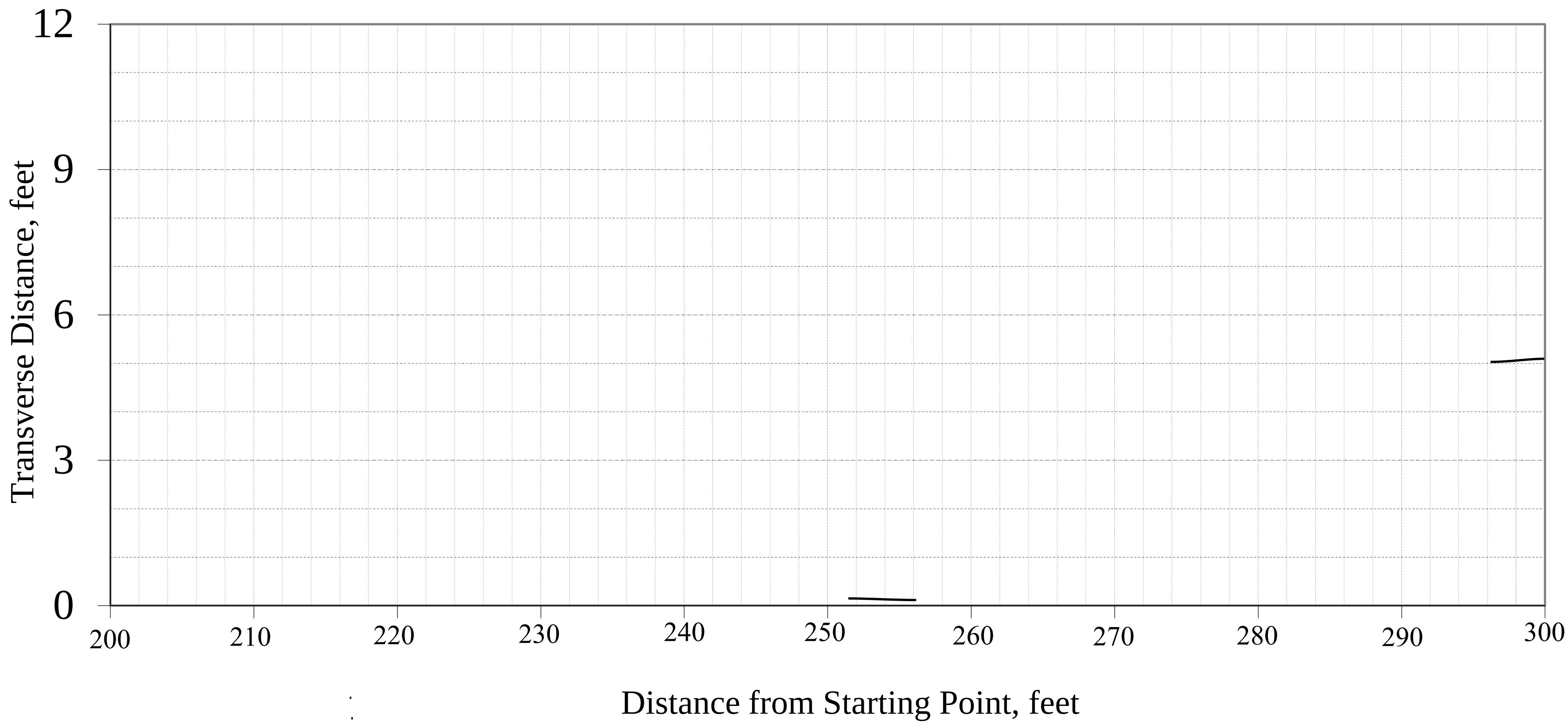
Appendix A: Distress Mapping of Existing Pavement before Placement of Micro
Project: PennDOT ECMS WO#3 - Micro Surfacing with Fiber

Date/Time: Jul 6, 2020

Surveyed by: M. Solaimanian

County: York

Route: Kenneth Road
Bound: South
Segment:
Offset:
Lane: Travel



REMARKS:

- Zero Mark is at the Torlley Rd., right before the catch basin storm drain.
- All shown cracks on this page and subsequent pages have been sealed and are not visible.
- Survey was conducted from the roadside.
- Location and length of all mapped cracks are approximate.
- The road is in good shape. Raveling is minor,. There was no visible rutting.

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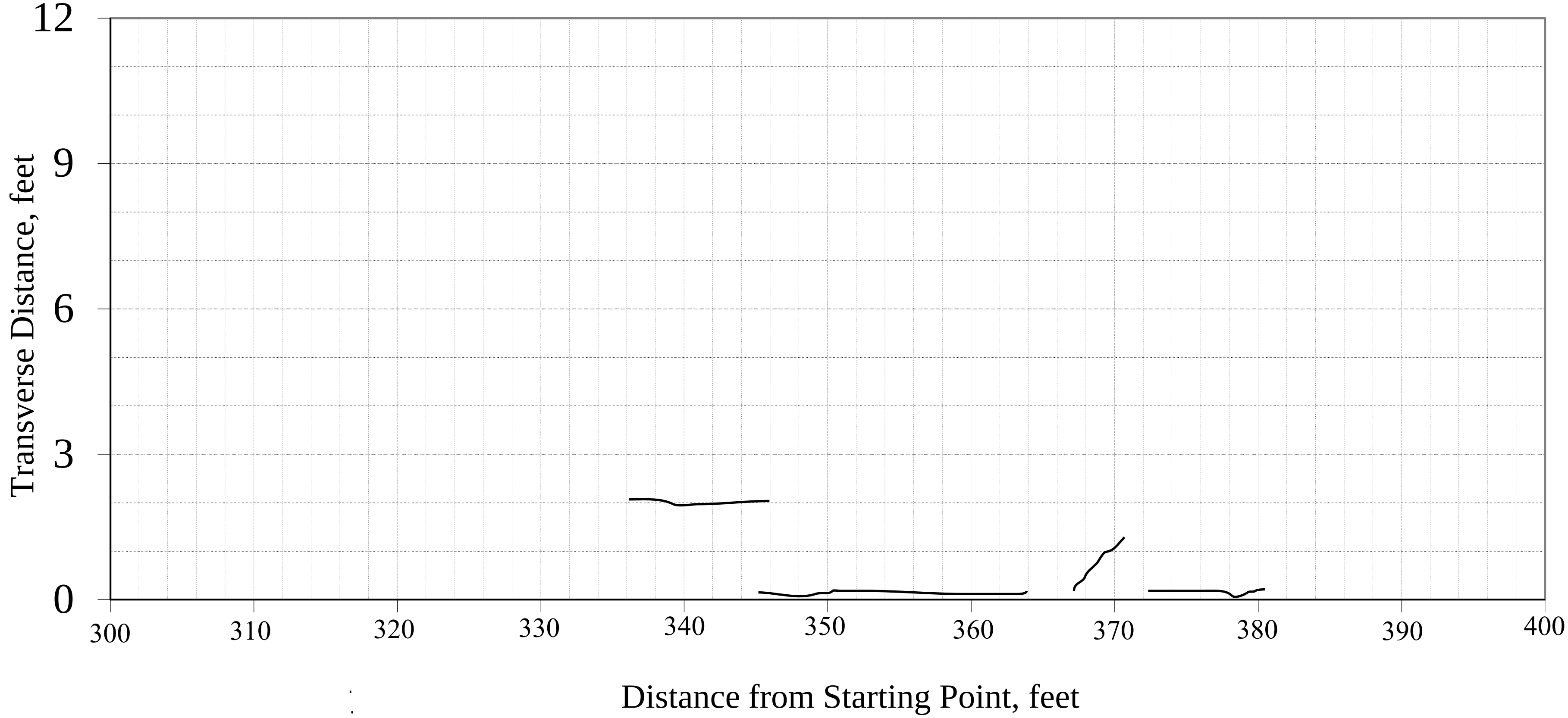

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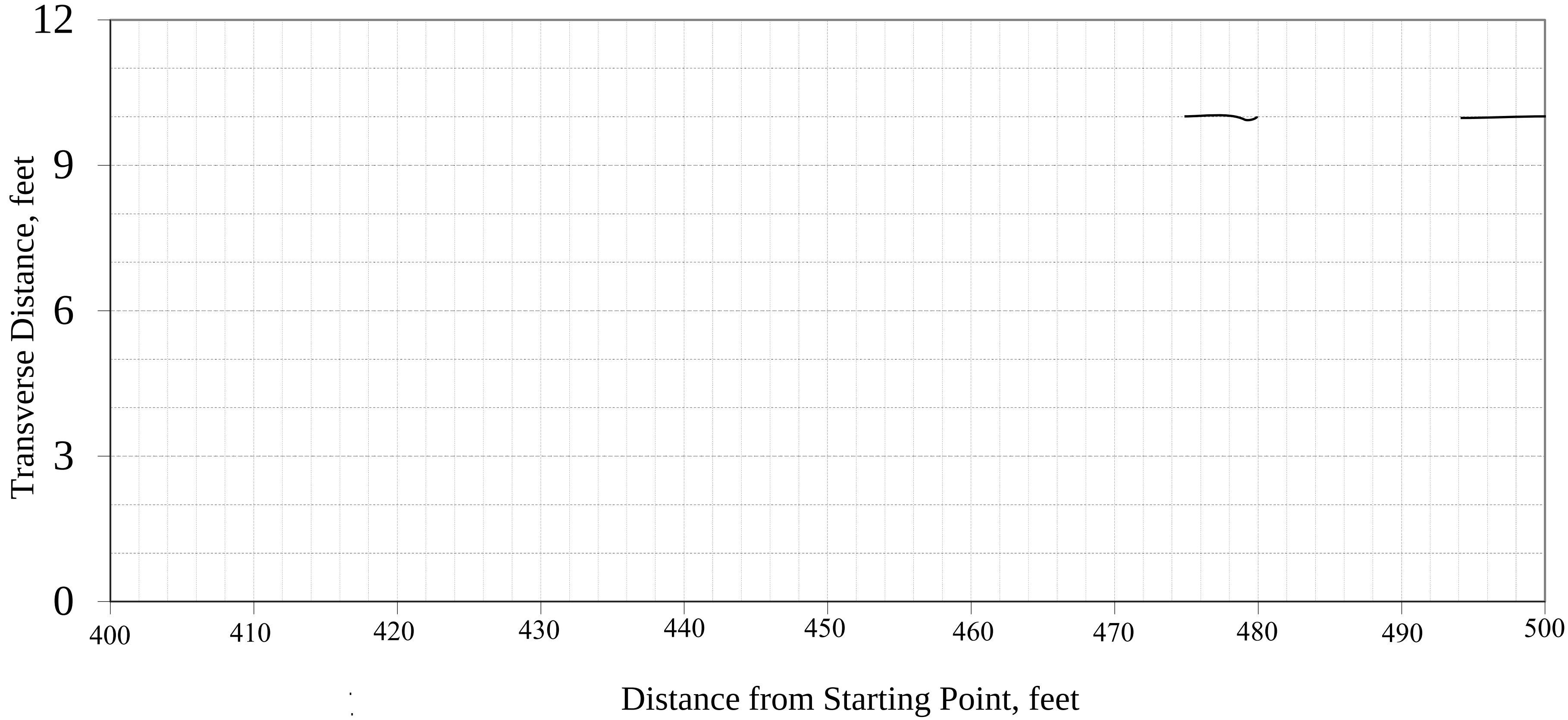

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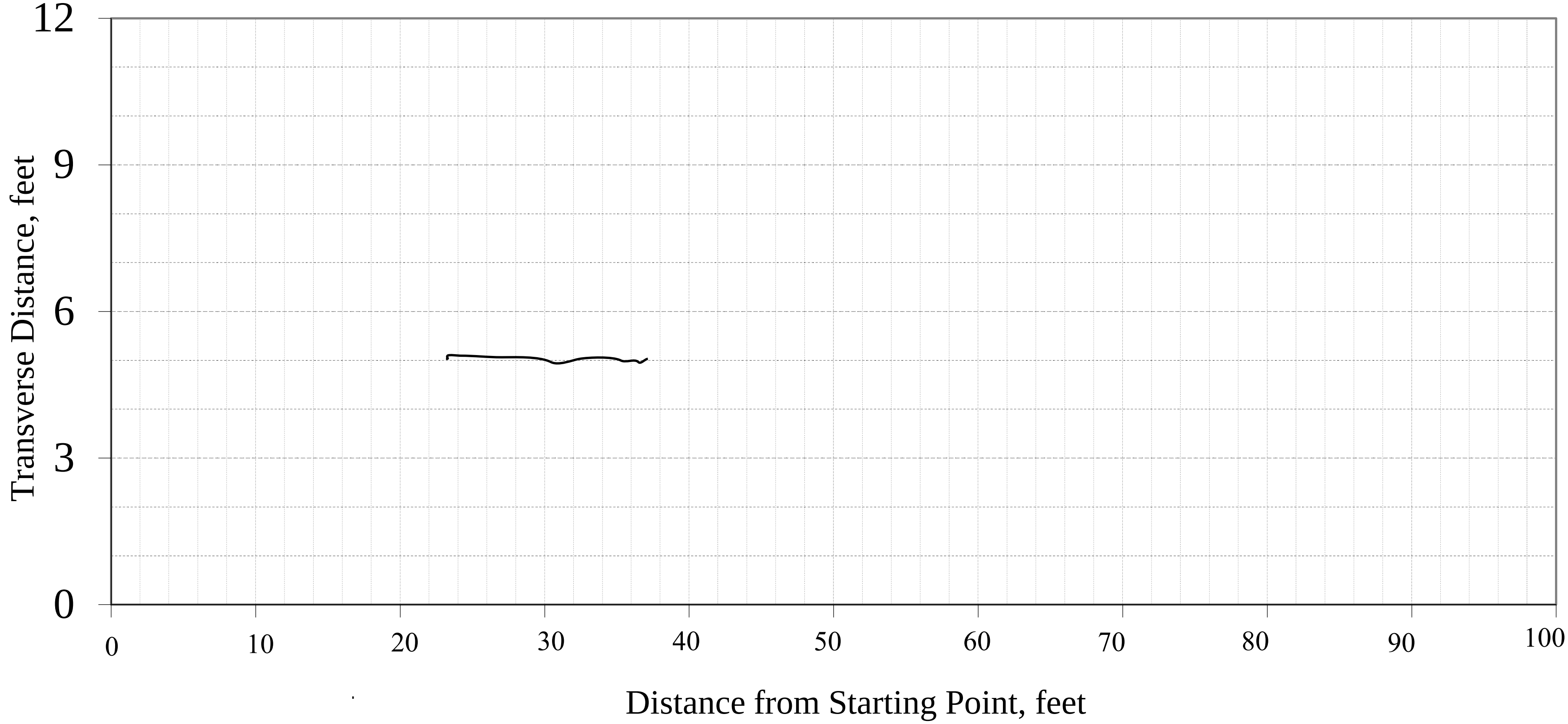
County: York

Route: Kenneth Road
Bound: North
Segment:
Offset:
Lane: Travel



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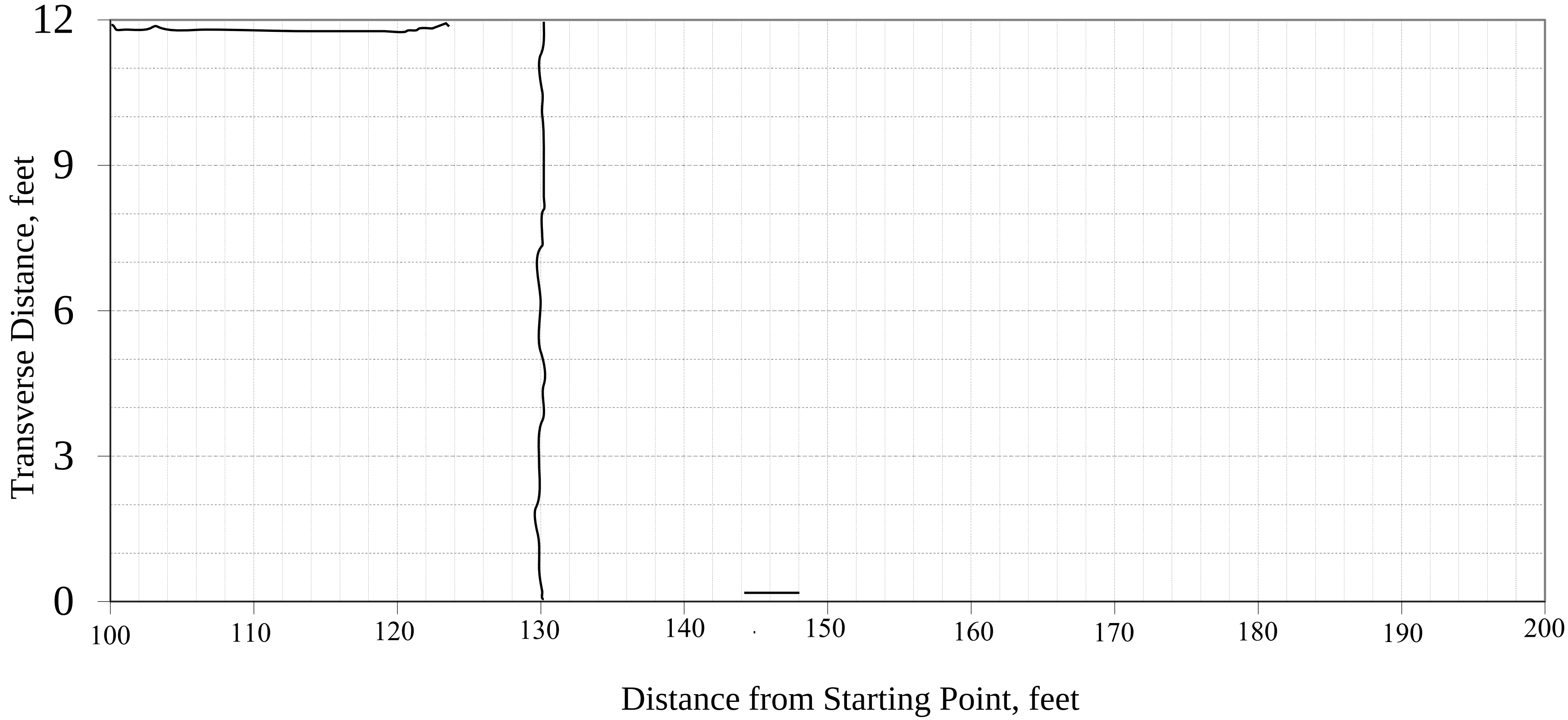

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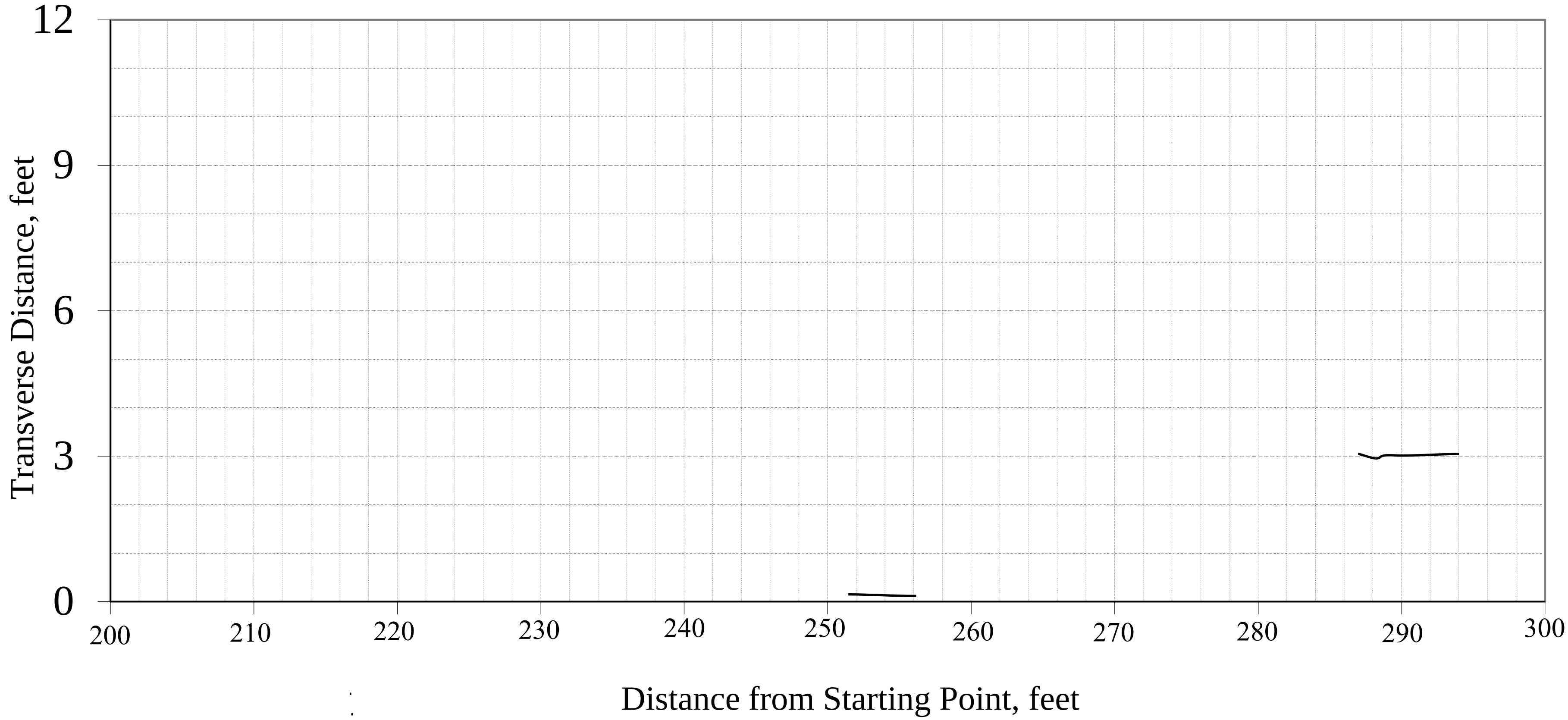

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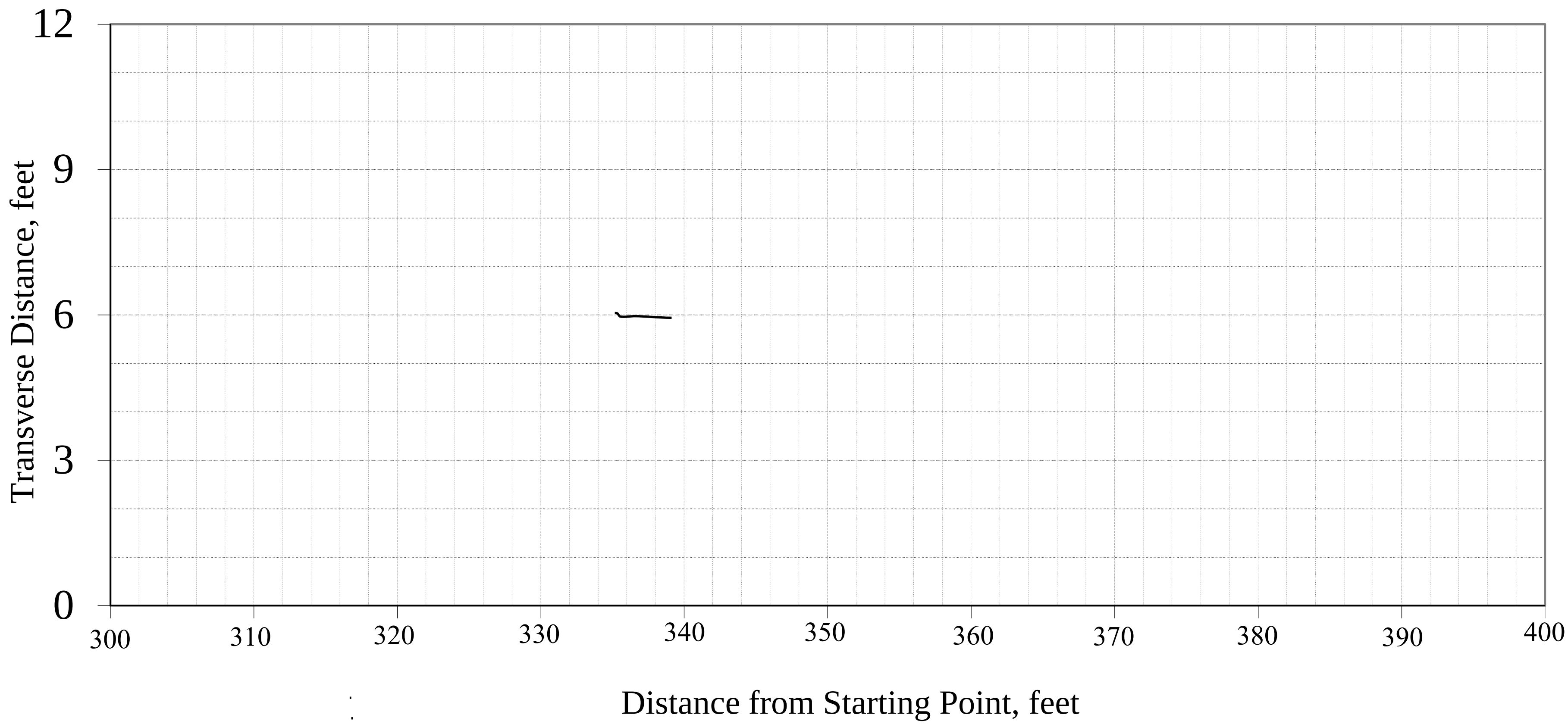

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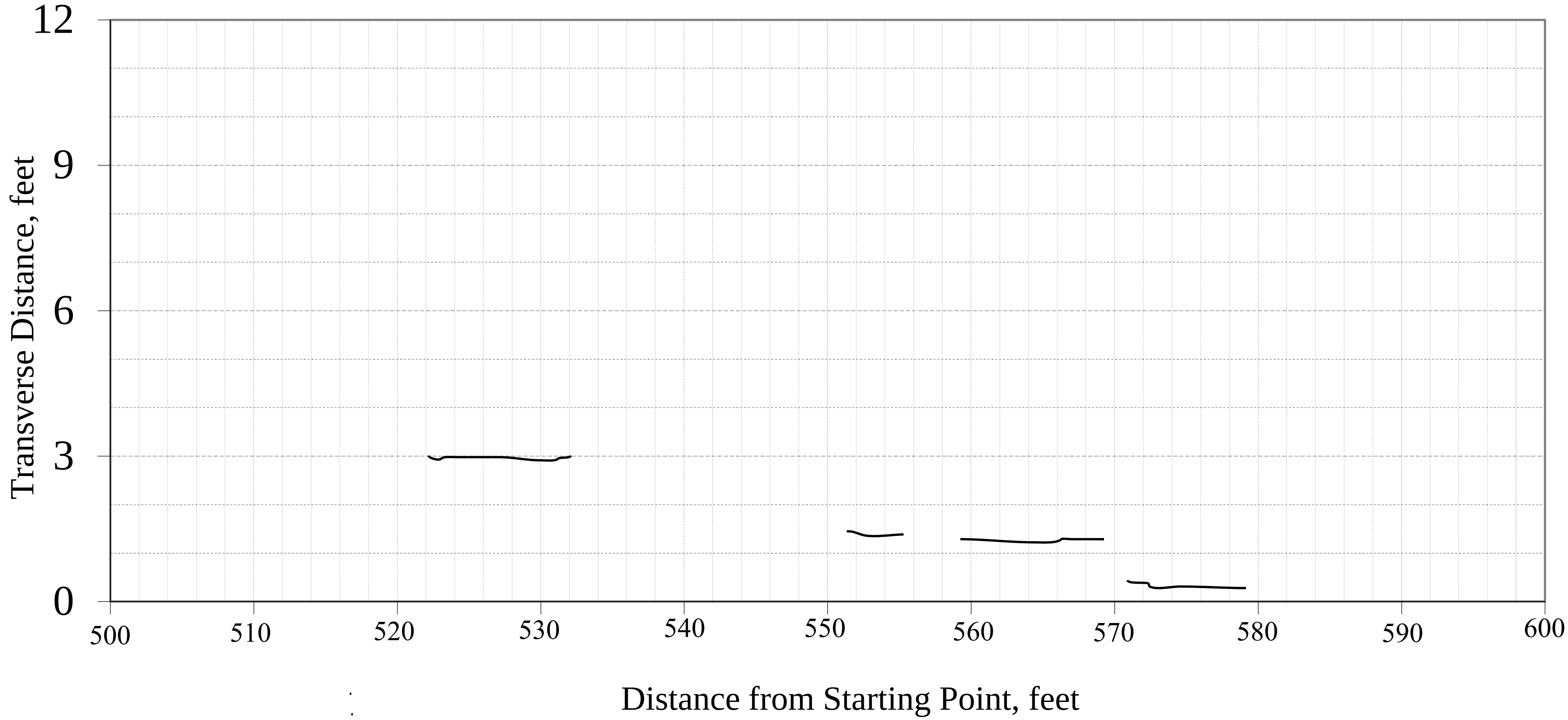

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- Location and length of all mapped cracks are approximate.
- The road is in good shape. Raveling is minor,. There was no visible rutting.
- No cracks or sealed cracks were observed in the 400 to 500 ft. distance and hence not reported.

Distress Survey Form (page 1/1)

Project:_**PennDOT ECMS WO #3 – Microsurfacing with Fiber**

Rte/Section: Kenneth Road, Southbound, Travel Lane County:York, Manchester Township

Date: 7/6/2021 Begin Survey At: Trolley Rd.

Time: Mid-morning to early afternoon End Survey At: Loucks Rd.

DISTRESS TYPE			SEVERITY LEVEL		
			LOW	**MODERATE**	**HIGH**
1	**FATIGUE CRACKING**	(ft^2)	NONE	_ _ _ . _	_ _ _ . _
2	**BLOCK CRACKING**	(ft^2)	NONE	_ _ _ . _	_ _ _ . _
3	**EDGE CRACKING**	(ft)	52	_ _ _ . _	_ _ _ . _
4	**LONGITUDINAL CRACKING**				
	Wheelpath	(ft)	64	_ _ _ . _	_ _ _ . _
	Length Sealed	(ft)	64	_ _ _ . _	_ _ _ . _
	Non-Wheelpath	(ft)	4	_ _ _ . _	_ _ _ . _
	Length Sealed	(ft)	4	_ _ _ . _	_ _ _ . _
5	**JOINT REFLECTION CRACKING**				
	Transverse Jt. Cracking	(ft)			
	Transverse Jt. Cracking	(number)	_ _ _	_ _ _	_ _ _
	Length Sealed	(ft)	_ _ _ . _	_ _ _ . _	_ _ _ . _
	Longitudinal Jt. Cracking	(ft)	_ _ _ . _	_ _ _ . _	_ _ _ . _
	Length Sealed	(ft)	_ _ _ . _	_ _ _ . _	_ _ _ . _
6	**TRANSVERSE CRACKING**				
	Number of Cracks	(number)	2	_ _ _	_ _ _
	Length	(ft)	3	_ _ _ . _	_ _ _ . _
	Length Sealed	(ft)	3	_ _ _ . _	_ _ _ . _
7	**PATCH/PATCH DETERIORATION**				
	Number of Patches	(number)	NONE	_ _ _	_ _ _
	Area	(ft^2)	_ _ _ . _	_ _ . _	_ _ _ . _

Distress Survey Form (page 1/1)

Project:_**PennDOT ECMS WO #3 – Microsurfacing with Fiber**

Rte/Section: Kenneth Road, Northbound Travel Lane County: York, Manchester Township

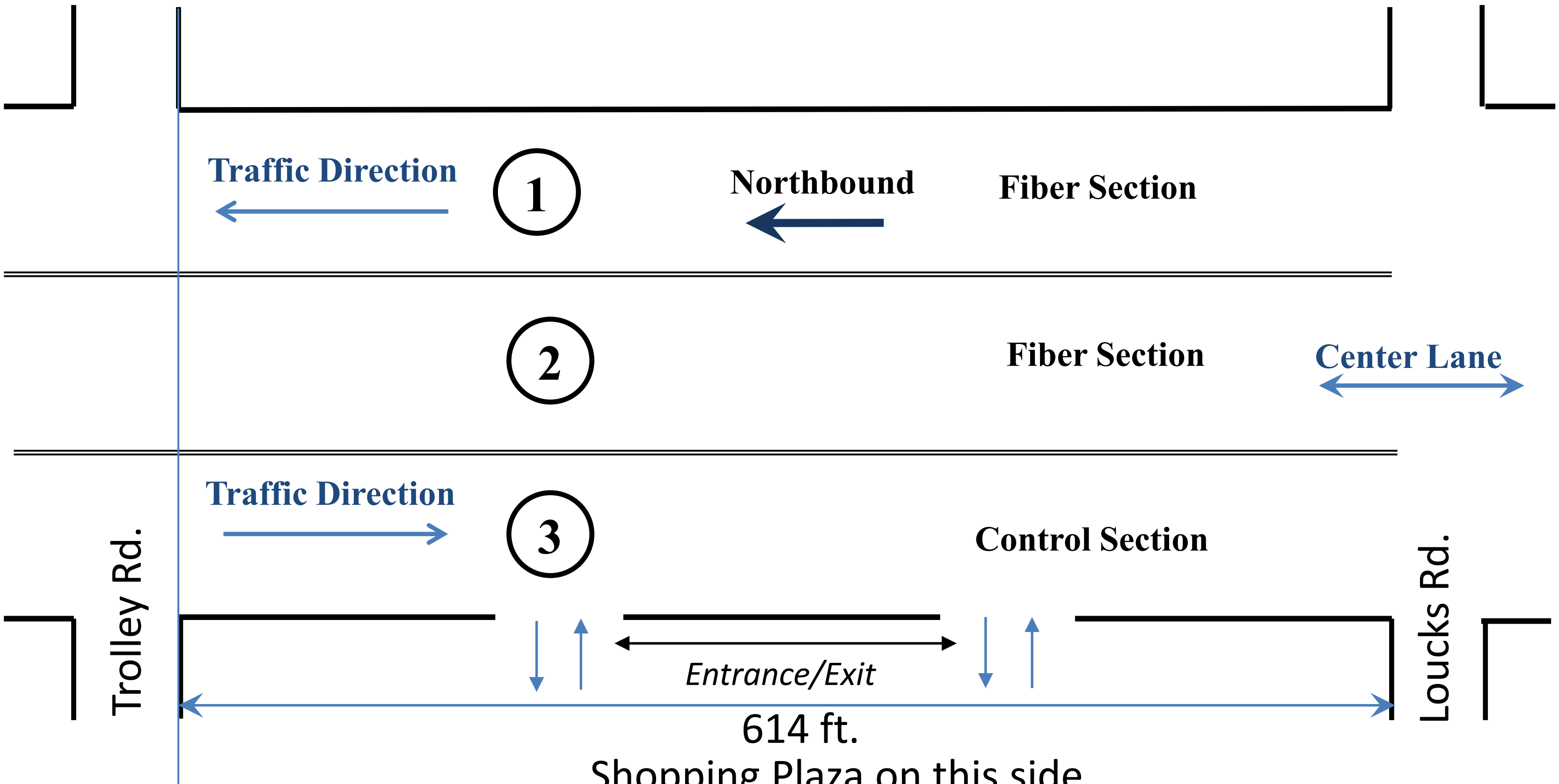
Date: 7/6/2021 | Begin Survey At: Loucks Rd.

Time: Mid-morning to early afternoon | End Survey At: Trolley Rd.

DISTRESS TYPE			SEVERITY LEVEL LOW	MODERATE	HIGH
1	**FATIGUE CRACKING**	(ft^2)		___ . _	___ . _
2	**BLOCK CRACKING**	(ft^2)		___ . _	___ . _
3	**EDGE CRACKING**	(ft)	4	___ . _	___ . _
4	**LONGITUDINAL CRACKING**				
	Wheelpath	(ft)	17	___ . _	___ . _
	Length Sealed	(ft)	17	___ . _	___ . _
	Non-Wheelpath	(ft)	30	___ . _	___ . _
	Length Sealed	(ft)	30	___ . _	___ . _
5	**JOINT REFLECTION CRACKING**				
	Transverse Jt. Cracking	(ft)			
	Transverse Jt. Cracking	(number)	___	___	___
	Length Sealed	(ft)	___ . _	___ . _	___ . _
	Longitudinal Jt. Cracking	(ft)	___ . _	___ . _	___ . _
	Length Sealed	(ft)	___ . _	___ . _	___ . _
6	**TRANSVERSE CRACKING**				
	Number of Cracks	(number)	1	___	___
	Length	(ft)	12	___ . _	___ . _
	Length Sealed	(ft)	12	___ . _	___ . _
7	**PATCH/PATCH DETERIORATION**				
	Number of Patches	(number)	NONE	___	___
	Area	(ft^2)	___ . _	__ . _	___ . _

Appendix B: Micro Surfacing Site Layout

Project: Micro Surfacing with Fiber
West Manchester Township, York County, PA



Paving Sequence: Numbers 1, 2, and 3 indicate sequence of micro surfacing

Two layers of type A micro surfacing were applied: a scratch layer and a top layer
Placement Date: July 7, 2020